Contents lists available at www.innovativejournal.in

Asian Journal of Computer Science and Information Technology

Journal homepage: http://www.innovativejournal.in/index.php/ajcsit

ISSN 2249 - 5126

GREENING THE CAMPUS:DESIGN OF A GENERIC GREEN IT MODEL FOR POSSIBLE ADOPTION. (A CASE STUDY OF AN EDUCATIONAL INSTITUTION IN NIGERIA)

Awodele Oludele; Malasowe Bridget O., Onuiri Ernest E.

Department of Computer Science, Babcock University, Ilishan-Remo, Ogun State; Nigeria

ARTICLE INFO

Corresponding Author:
Awodele Oludele
Department of Computer Science, Babcock University, Ilishan-Remo, Ogun State; Nigeria
delealways@yahoo.com

KeyWords: Corporate Social Responsibility, Carbon footprints, Cloud Computing, Grid Technology, Green IT Framework, Green Technologies, Virtualization.

ABSTRACT

Society's reliance on Information Technology (IT) has increased tremendously in the last few decades. Unfortunately, the growth of the IT sector has seemingly occurred at the expense of the environment. The adverse environmental impact of IT operations is partly due to the production and disposal of IT equipment, which gives rise to the release of harmful pollution agents and toxic materials into the environment. The push for carbon footprint reduction by the international community and the realization by major IT organizations on the adverse effect of their operations on the environment are forces behind the evolution of the green IT framework. This reasearch work focuses on measuring the Carbon Footprint of an educational institution in Nigeria and the design of a Generic Green IT Model for possible adoption. The scopes laid out by the GHG (Greenhouse Gas) Protocol was adopted for this research. The CO_2 emission from Scope 1 (Fuel and diesel consumption on campus), scope 2 (purchased electricity) and scope 3 (staff and student commuting) were calculated respectively. Emission factor–based calculation approach was used to calculate the CO_2 emission of the institution (WRI – World Resources Institute). The result of this calculation was used to design a Generic Green IT Model.

1. INTRODUCTION

To be 'socially responsible' is the current buzzword in the business domain and is being implemented by all types of organizations from SMEs (Small and Medium size Enterprises) to multinational corporations and conglomerates. The ways by which a company present itself as a socially responsible corporation include philanthropic programs, sponsorships, volunteerism, code of ethics, enrichment programs, health and safety programs and environmental programs (McWilliams & Siegel (2001); Porter & Kramer (2002)). These are a part of the green movement which is also the current trend of today's organization where the emphasis is on protecting the environment (McWilliams et al).

Carbon footprint "measures the amount of greenhouse gases, in units of carbon dioxide, produced by human activities" (Walser, 2010). A carbon footprint can be measured for an individual and also for an organization. The 'green' regulation like Restriction of Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) which was adopted by European Union in February 2003, in an effort to become more environmentally friendly. These regulations address the increasing electronic and electrical waste by restricting the use of toxic substances and flame-retardants in the manufacture of electrical and electronic equipment.

2.0 Literature Review

2.1 Concept of Green Technology

According to Nayab (2011), the importance of Green Technology was made evident when computing attained critical mass in the early 1990s. The late 1990s and early 2000s witnessed many regulatory milestones. Consequently, many companies responded with innovations to incorporate green technology as the years wore on. The first major landmark in the history of Green Computing was the United States Environmental Protection Agency (EPA)'s Energy Star program, launched in 1992. Also, a landmark event in the history of green technology is the 1997 Kyoto Protocol for the United Nations Framework Convention on Climate Change. This protocol mandates reducing carbon emissions (Nayab, 2011).

2.2 The First Thoughts of Green IT Model

Graeme (2010) gave five key components of Green IT diagramatically represented in figure. 1

2.3 Categories and Operations in Green Initiatives

Minita (2011), in his prelimenary study, categorised and operationalized green initiatives into four groups These are:

- **Renewable Energy :** The energy generated from natural resources like sun, tides, wind.
- **Disposal of IT Equipment:** IT equipment should either be resold or sent back to the plant for recycling.

- **Green Data Centres:** Virtualization, Server Consolidation, WAN Optimization, Cloud Computing and Grid Computing are the few ways in which an organization can achieve Greener Network and hence Greener Data Centres.

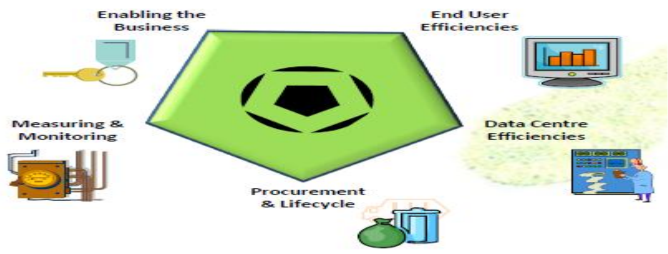

Figure 1: Five Key Components of Green IT (Source: http://www.greenitweek.org/downloads/GreenITFrameworkOverview.pdf)

- **Green Technologies:** Green Technologies are those technologies that help to conserve natural environment and resources and help to reduce the negative impact on humans and other living organisms.

2.4 What is Green IT?

Green Marketing TV (2010) defined Green IT as the practice of using information technology procedures, products and services in an environmentally responsible and friendly manner. It means that anything related to computing – from designing, manufacturing, using and disposing, is done with minimal impact to the environment. According to Kumar (2011), schools can benefit from Green Computing by taking steps to reduce the energy consumption of their technology systems. This would not only reduce environmental impact but also help to cut expenditure and reduce budget.

2.5 Green Computing Approaches on Campus

Thompson (1999) identified three approaches to Green IT Computing on Campus. These are as discussed below:

- Power management is built into PC operating systems, but users have additional choices, such as whether to turn off computers when not in use.
- E-mail can take the place of more costly practices, such as when users distribute print documents as e-mail file attachments rather than as paper copies.
- Online learning using learning management systems and web/videoconferencing can reduce the need for traditional classrooms and other infrastructure while decreasing travel costs and CO_2 emissions.

Thompson also went further to suggest that a reminder notice can be placed in all offices to turn off and unplug equipments. This research work proposes the notice in figure 2.

Figure 2: Notice for Offices

2.6 The Need For The Reduction of Carbon Footprint In Nigeria

According to Nnimmo (2007) "Climate change in Nigeria is a ticking time bomb and little or even nothing exists to mitigate its effects". Habil (2007) shared his view about the argument that Africa need not care about climate change because Africa produces negligible greenhouse gases. But, Africa will probably suffer most from its consequences. Africa produces one ton of CO_2 per person per year according to American statistics. Habil also went futher in expanciating the possible implications of CO_2 emission in Nigeria. From his estimates about 40% of the African Gross National Product is obtained in agriculture and 70% of all African labour is employed in this sector. The dominant role of agriculture makes it obvious that even minor climate deteriorations can cause devastating socio-economic consequences. Hence there is need for Nigeria to reduce her carbon footprint.

2.7 Computer Power Consumption

The IT department at Jefferson Community College (May 12, 1997) used a meter and found the following information about power usage for the desktop computers on campus. Jefferson Community College (JCC) computers are HP/Compaq DC7600/7700 (with some older EVO models). This might vary slightly for other desktop models:

- To boot computer with monitor on takes 160 Watts until OS loads then settles in at 115 Watts at Idle.
- Computer at Idle with both monitor and CPU running = 115 Watts.
- CPU running and power off on monitor = 60 Watts. When the monitor is powered on again, initially, it will jump to over 300 Watts for 2-3 seconds to start monitor.
- CPU running and unplugging monitor = 51 Watts.
- CPU and monitor on with Word running = 128 Watts.
- CPU and monitor on with Word and Netscape running = 135 Watts but takes an extra 20 Watts to load a different page in Netscape.
- Both CPU and monitor shut down still draws 12-13 Watts.

2.8 Existing Green IT Models

From a process technology perspective, Green Process Technologies can be classified as end of pipe technologies and clean technologies (Gonzalez, 2005). End of pipe technologies reduce the environmental impact of emissions without necessarily changing the production process.

2.8.1 GITAM Basic Model

Molla (2008) designed a Basic Model shown in figure 3. He also identified economic, regulatory and ethical issues as drivers of GREEN IT.

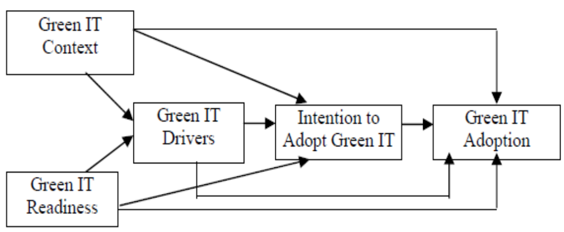

Figure 3: GITAM Basic Model (Source: http://www.bsec.canterbury.ac.nz/acis2008/Papers/acis-0152-2008.pdf)

2.8.2 Monroe Community College's (MCC's) Green IT Campus Model

According to Bartkovich (2008), Monroe

Community College (MCC) proposed a framework for a Green IT Campus Model. MCC's proposed Green IT Campus Model is organized into four categories. These are:

i. Power Consumption

- Purchase PCs, printers and other peripherals (for offices, computer labs, classrooms, libraries) that are compliant with the EPA Energy Star program or EPEAT.
- Address server virtualization and data center power usage and related HVAC (heat, ventilation and air-conditioning) issues.
- Place auto-controls on data projectors and bulbs in smart classrooms and campus meeting and conference rooms.

ii. Recycling

- Implement a recycling program for:
  - PCs, monitors and peripherals (partner with vendors, as needed) Mobile devices
  - Batteries
  - Toner
  - Outdated software CDs
  - Shredded and baled paper
- Use packaging that the technology/equipment is delivered in, e.g., Styrofoam, plastic, cartons, etc. that may be re-purposed for lab experiments if green issues are designed into the curriculum.
- Utilize recycled paper for copying and printing.
- Address strategies for a reduction in paper usage throughout the institution—better education for end users on how to print one page only from web sites, emails, etc.
- Implement an imaging system that reduces the amount of files that need to be retained in hard copy.
- Seek advice from campus records and retention experts to determine measures that may reduce the amount of college-related hard copy archives and the space needed to retain these files.
- Implement a process for weeded library journals to be made available to other libraries to help fill gaps in collections.
- Re-use manila envelopes, jiffy bags and fabric shipping bags for Interlibrary Loan (Bartkovich, 2008).

iii. Transportation and Fuel Conservation

Online courses (asynchronous and blended) reduce students' need to regularly drive to on-campus sites for classes.

- Use of videoconferencing between campus sites can reduce travel and save time for faculty, staff and administrators.
- Use of webinars, webcasts and audiocasts for professional development can reduce travel—and travel costs—and save time for faculty, staff and administrators.
- Use of enterprise-wide online informational and transactional applications (i.e., Banner) allows for online access to student services and records; reduces the need for additional student travel to campus to request a transcript, to register for a course, to complete a Housing application,to view their schedules and grades, etc.
- Use of enterprise-wide online informational and transactional applications allows for online access to campus records, and reduces faculty, staff and administrator travel to campus sites on evenings and weekends.
- Use of a VPN (Virtual Private network) allows faculty, staff and administrators to securely access their electronic files without traveling to campus on nights and weekends (Bartkovich, 2008).

iv. Other Campus IT Sustainability Items

Use of an integrated email delivered pay stub reduces paper and postage costs.

- Use of integrated reporting applications (i.e., Web Focus and e~print) saves paper and provides time savings when looking for records online.
- Use of online timesheets reduces paper usage, provides 24/7 access to input and approval of time sheets and reduces the need for travel to a campus-based site to sign hard copies of timesheets.
- Use of a pay-for-print system may reduce unnecessary or "frivolous" printing—people requesting printed pages that they never collect, erroneously submitting one print job multiple times, or printing several pages instead of the one page that is wanted.
- Create department-specific records retention schedules so that only necessary records are retained.
- Use of microfiched records that the institution is legally compelled to retain permanently reduces needed storage space and preserves records for future retrieval.
- Replace alkaline battery flashlights with rechargeable emergency flashlights.
- Minimize press runs of hard copy campus publications, consistent with actual need (Bartkovich, 2008).

3.0 Understanding Key Greenhouse Gas Accounting Concepts

Over the past decade, the World Business Council for Sustainable Development and the World Resource Institute (WBCSD/WRI) jointly established a set of accounting standards to guide organisations in their emissions-reporting. According to WBCSD/WRI (2004) there are three types of boundaries to consider in taking GreenHouse Gas Accounting. These are - Organizational, Operational and Temporal. GHG accounting and reporting is based on the following principles: relevance, completeness, consistency, transparency, and accuracy (WBCSD/WRI). The scopes laid out by the GHG Protocol are as follows:

Scope 1 – Direct emissions from sources that are owned and/or controlled by an institution such as:

- On-Campus Stationary Sources
- Direct Transportation Sources
- Refrigeration and other Chemicals
- Agriculture

Scope 2 – Indirect emissions from sources that are neither owned nor operated by an institution but whose products are directly linked to on-campus energy consumption. This includes purchased energy (Purchased Electricity, Purchased Steam, Purchased Chilled Water).

Scope 3 – Other emissions attributed to an institution, deemed "optional" emissions by corporate inventories. (solid waste emissions from managing the institution's waste), incineration, landfilling, etc. Directly Financed Outsourced Transportation Emissions.

There are two main categories of calculating tools used to calculate CO_2 emissions. These are:

a. **Cross-sector tools:** this can be used for a variety of sectors. These include tools for calculating GHG emissions from stationary combustion, mobile combustion, and the use of HFCs (hydrofluorocarbons) in refrigerators and air conditioners.

b. **Sector-specific tools:** these are designed to calculate emissions in sectors such as iron and steel, oil and gas, and pulp and paper, aluminum and cement.

3.1 Data collection

For the purpose of this research work the interview method of data collection was used because of the nature of the inventory. The Higher Technical Officer (HTO) the institution was interviewed, he was able to give the quantity of fuel/diesel that is used on campus owned power generating sets and also the estimated amount/quantity of fuel/diesel used to run the institution's vehicles. Also, the secretary of the consultany department on campus and owners of business centres was interviewed to get the quantity of diesel/fuel consumed. Furthermore, the works department measured the distance travelled by cars and bikes alike within the campus. Furthermore, the campus was measured with the assistance of the works department to get the distance moved within the campus by staff and students.

Questions such as: what quantity of fuel/diesel is used per day to run the generator? How many hours a day is the generator run? How many times a week is the generator used? How many vehicles are owned by the institution and how often are they in use? What quantity of fuel/diesel is used to run these vehicles.

Data gathered from the campus are:

i. Emission sources on campus

For the permanent site, a drum of diesel which contains 250 (two hundred and fifty) litres of diesel is put to use whereas the temporary site consumes half of a drum of diesel.

ii. Car Consumption on campus

It was gathered that any local run i.e movement of vehicle within the state, 3,000.00 Nigerian Naira fuel is used and outside the state 5,000.00 Nigerian Naira fuel is used this amount was estimated by dividing the amount of a litre fuel sold in that area to get the activity data.

Given the amount of fuel per liter as 120.00 Nigerian Naira to get number of liters consumed.

Further estimation was made in the movement of vehicles – movement outside the State is estimated to be about four (4) times in a month while movement within the state is also estimated to be about four (4) times a month. Sometimes there might be no movement outside the state within a month. Hence, it is estimated that 200 litres of fuel is used within a month. Consultancy uses 40 liters of fuel in two weeks. Given the fact that public power supply in Nigeria is epyleptic – the school is likely to get power supply for a paltry one hour in a week.

It was also gathered that about six business centres use about 10-13 litres of diesel daily while others within the same area under review use about 5 - 7 litres of fuel daily.

Further interview with the HTO, the secretary and the operators of the business centres revealed that the same quantity of fuel/diesel was used for about a period of seven (7) to eight (8) months within the calender year chosen for this research work. Also, the payment of elctricity bill was the same for about a period of 8 months.

3.2 Measuring Emissions (WBCSD/WRI) - Emission Factor–Based Calculation Approach

An emission factor is a coefficient that quantifies the emissions or removals of a gas per unit activity, and it is often based on a sample of measurement data, derived as a representative rate of emissions for a given activity level under a particular set of operating conditions.

Emission factors have been developed for specific emission-generating activities or processes for all five different source types (stationary combustion, mobile combustion, process emissions, fugitive emissions, and waste emissions), as well as for carbon sinks. In addition, different emission factors have been developed for the different activity data available for the estimations.

According to IPCC (2006), emission factors may be developed using data from periodic sample testing or stack testing, mass balances, control equipment specifications, and/or emission models. Most factors are averages of all available data of acceptable quality, and they generally are assumed to represent long-term averages for all facilities in the source category. Other measuring techniques are - mass (material) balance measures, predictive emission–monitoring systems (PEMS), and continuous emission–monitoring systems (CEMS). For the purpose of this research work Emission Factor–Based Calculation Approach was used.

The general equation for emissions estimates is -

CO_2 emission = Activity data (kg / km / litres / etc) * Emission factor (CO_2 per unit).

or

$E = A \times EF$

Where

E = CO_2 emissions

A = activity data (e.g., fuel consumed, material input, throughput, or production output)

EF = emission factor (usually the weight of the pollutant or the unit weight, or the volume or duration of the activity, e.g., tons of CO_2 or tons of coal. Published emissions factor is used to convert activity data to an emissions value.)

For the purpose of this research work the calendar year for the calculation of CO_2 emission is set to be January 2011 – December 2011

Diesel

Petrol

- Diesel: 1litre = 2.68kg CO_2
  Petrol: 1 litre = 2.31kg CO_2
- Diesel: 1 gallon = 12.18kg CO_2
  Petrol: 1 gallon = 10.5kg CO_2

3.2.1 Measuremnt of The Campus To Get Distance Covered by Staff and Student Commuting

School gate – exit gate 372.5 meters, Agric – languages 585 meters, Agric to roud about 286 meters, Round about 14 meters, Round about - language 285 meter, Gate – rouund about 224.5 meters, Round about – exit gate 134 meters. All values were extrapolated to get the activity data for the calender year (January 2011 – December 2011.) There was no proper documentation on the number of visitors to the school as at the time of this data collection.

4.0 Analysis of Data Gathered and Calculation of Emissions on Campus

During data gathering, it was observed that the institution has two (2) sites – temporary and permanent site. Each site has a power generator which is run for about eight (8) hours each day, five days in a week. It was also gathered that the temporary site uses half a drum of diesel, while the permanent site uses a full drum of diesel each day. According to the HTO, 250 litres of diesel is estimated to be in a drum hence, the permanent site uses that amount of diesel per day. This multiplied by five (5) days in a week will give 1,250 litres – total consumption per week

Total Consumption in a year = 12 month x (total consumption per week x 4 weeks)**= 60,000 litres of diesel in a year**

The permanent site is estimated to use 60,000 litres of diesel in a year.

The temporary site uses half drum of diesel per day which is half of what the permanent site uses.

Hence temporary site uses **30,000 litres of diesel in a year.**

4.0.1 Fuel Usage of Vehicles Owned by the Institution

The following principal officers of the institution are attarched with the following number of car(s) for the day-to-day admistrative work of the institution: Provost - 2 cars, Deputy Provost - 1 car, Rigistrar - 1 car, Bursar - 1 car, Chief Librarian - 1 car,

There are also four (4) other vehicles used for the day-to-day administartive work of the institution. The fuel consumption of these cars is estimated to be - 200 litres per month .

Total consumption in a year = 200 litres * 12 **= 2400 litres**

It was also gathered that there is a Consultancy department that runs its own personnal power generator. The geneator uses 40 litres of fuel per week.

Total Consumption in a year = 12 months x (total consumption per week x 4 weeks)**= 1,920 litres of fuel in a year**

4.0.2 Staff commuting (staff owned vehicles)

The staff strength of the institution is put at about 1,016 as at December, 2011. Out of this number, 700 have cars while 200 use motor bikes. The school is located on about 50 hectares of land along the Agbor – Sapele road in Delta State, Nigeria. The school faculties and departments are clustered and requires no intra department commuting. Staff members walk to and from other faculty buildings, departments and lecture rooms where required.

The estimated longest distance from the entrance (gate) 585 meters and shortest distance is about 224.5 meters at the permanent site. At the temporary site, the longest distance is about 300 meters and shortest distance is estimated to be 204 meters from the entrance.

To get the estimated average distance travelled add longest and shortest dist in both sites then divide by two. This totaled 656.75 meters.

Members of staff using cars and bikes move a distance of about 656.75 meters each day within both sites each day.

To get total the distance covered by all cars – 700 cars x 656.75 meters = 459,725 meters per day.

Multiply this value by 2 to get the bi-directional movement – (459,725 x 2) = 919,450 meters per day.

Total distance covered in a year = ((Total distance covered per day x 5 days) x 4 weeks) x 12

= 220668,000 meters per year (cars) or 220,668 kilometer

Further assumption of 15% higher car fuel consumption is made because the cars are not new. Hence 15% of 220,668 is equal to 33,100.2

Adjusted combined gross total average car fuel consumption per kilometer

= 220,668 +33,100.2 **= 253,768.2 kilometers**

4.0.3 Total distance traveled by motor bike (staff owned)

200 motor bikes x 656.75 meters (for each bike) = 856.75 meters per day

Total distance covered in a year = ((Total distance covered per day x 5 days) x 4 weeks) x 12

Multiply by 2 to get to and fro movement - 411240 meters or 411,24 kilometer per year (motor bike (staff owned))

4.0.4 Student commuting (by bike)

The School is non-residential. Therefore substantial number of the students move in and out of the school premisses by motor cycles. About 100 commercial motorcycle operators are officially registered to enter the institutions' campuses. Longest distance travelled is about 372.5 meters while shortest distance is 224.5 meters. Total of shortest and longest distance travelled divided by two to give average distance travelled.

100 bikes x 298.5 meters = 29,850 meters per day

Total distance covered in a year = ((Total distance covered per day x 5 days) x 4 weeks) x 12

= 7,164,000 = **7,164 kilometers**

4.0.5 Total Average bike distance travelled in a year (staff and student)= 48288 kilometers

Business Centres on Campus

– diesel consumption on campus is estimated to be = 22 litres per day

Diesel consumption per week = 22 litres *5
= 110 litres of diesel

Total Consumption in a year = 12 months x (total consumption per week x 4 weeks)

= 5,280 litres of diesel in a year

- **Fuel consumption on campus is estimated to be = 51 litres per day**

Per week fuel consumption = 51 litres *5
= 255 litres of fuel

Total Consumption in a year = 12 month x (total consumption per week x 4 weeks)

= 12240 litres of fuel in a year

4.0.6 Purchased Electricity

It was also gathered that the campus consumes 1633 kwh of electricity (purchased electricity – scope 2) per month.

For a year consumption = 1633 kwh * 12 months

= 19596 kw electricity in a year

Activity data = quantification of an activity of emissions source (e.g., air miles traveled, kWh of electricity used, etc.).

4.0.7 CO_2 Emission factors used for calculations (time for change)

FUEL TYPE	UNIT	CO_2 EMITTED PER UNIT
Petrol	1 Gallon	10.4kg
Petrol	1 Litre	2.3kg
Diesel	1 Litre	2.7kg

4.1 Emission factor for purchased electricity

According to Brander, Sood, Wylie, Haughton and Lovell (2011), corporate greenhouse gas accounting involves quantifying the greenhouse gas emissions associated with a business or organisation's activities, including the consumption of grid electricity. Electricity consumption is often one of the largest sources of emissions for reporting companies, and it is therefore important that the measurement of these emissions is as accurate as possible. However, for the majority of countries the best available factors for calculating emissions from electricity consumption are the composite electricity/heat emission factors published by the International Energy Agency (IEA 2010), which are also the basis for most of the grid electricity factors in the WRI tool for emissions from purchased electricity (WRI 2011), and Defra/DECC's factors for non-UK countries (Defra/DECC 2011a). The emission factor of purchased electricity is calculated in a regional form- Nigeria Electricity-specific emission factors ($kgCO_2/kWh$) is 0.43963136 (ecometrica, 2011). See table 1.

4.2 Calculating CO_2e (CO_2 equivalent) emission on Campus in tabular form (see table 1)

CO_2 emission = Activity data (kg / km / litres / etc) * Emission factor (CO_2 per unit).

Table 1. Calculation of CO_2 emissions

SCOPES	SOURCES OF EMISSIONS	ACTIVITY DATA	EMISSION FACTOR	CO_2E KG
Scope 1	Diesel consumption. (Generator)	90,000 litres	2.7 kg	243,000
	Fuel consumption. (Consultancy)	1,920 litres	2.3 kg	4,416
	Fuel Consumption (Cars)	2,400 litres	2.3 kg	5,520
	Diesel consumption (Business centres)	5,280 litres	2.7 kg	14,256
	Fuel consumption. (Business Centre)	51 litres	2.3 kg	117.3
Scope 2	Purchased Electricity	19,596 kw	0 .43963136 kg CO_2/kWh)	8,615.0161
Scope 3	Staff commuting (car)	253,768.2 km	2.3kg	583,666.86
	Staff/Student commuting (bike)	48,288 km	2.3kg	111,062.4
Total Emission on Campus				**970,653.5761**

4.3 Overview of Model Design

According to wikipedia (the free encyclopedia) scientific modeling is the process of generating abstract, conceptual, graphical and/or mathematical models.

Hence, this research work adopts The GITAM Basic Model dipicted in figure 3 as a basis for the design of a Generic Green IT Model for a High Institution for Possible adoption due to the following considerations:

- It constitute basic facts needed to design a Model for any organisation
- It stands as a starting point for other models
- Green IT awareness is still very low hence a basic, easy to understand and implementable model is necessary.

4.3.1 Green IT Designed Model

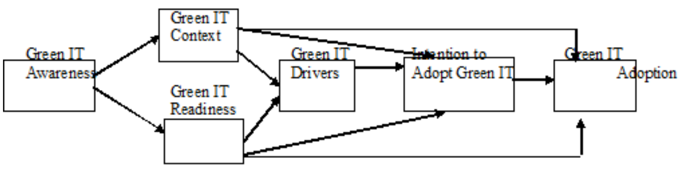

Figure 4 A Generic Green IT Model

During the process of data collection for this research work, it was observed that almost all the people within the campus community were not aware of prevalent GREEN IT concepts. Further study of the GITAM Basic Model (2008) which was adopted by this research work, it was observed that there is the need for organisations to first be aware of GREEN IT. The model in figure 4 is as discussed in the following paragraphs:

4.3.1.1 Green IT Adoption and Adoption Intention

Gitam (2008), differentiated between intention and actual adoption of Green IT. This is because emerging studies indicate that even if organisations are concerned about the environment and are intending to do something about it, they have yet to take concrete actions (Olson, 2008; Esty et al, 2006).

4.3.1.2 Drivers of Green IT

Molla, 2008 identified three drivers of Green IT. These are:

➢ **Economic** driver – This refers to the need for greater IT efficiency and the pursuit of tangible cost savings from IT operations.

➢ **Regulatory driver** refers to the pursuit of legitimacy within the wider social context (DiMaggio et al, 1983).

➢ **Ethical** driver refers to the pursuit of socially responsible business practices and good corporate citizenship.

4.3.1.3 Green IT Context

The Green IT context represents the primary characteristics that are inherent in the adoption context and can be assessed relatively objectively. The Green IT context includes - Technological context, Organisational context, Environmental context, Green IT Readiness (Gitam 2008).

4.3.1.4 Green IT readiness captures a dynamic assessment of an organisation's own and environment preparation to accept Green IT. It captures the perceptual characteristics of the adoption context (Molla, 2008).

4.3.1.5 Green IT Awareness

'Going green' is a hype within the IT industry and one cannot afford to surpass it when better positioning a company's corporate social responsibility strategy. Going green also offers opportunities to reduce energy consumption, and to lower CO_2 emissions. Reducing cost is a priority in the current economic climate (Atos Consulting, 2009).

To create Green IT awareness in our society GREEN IT awareness workshops should be organised. Atos Consulting designed a Board Game, Greenology as part of their Green-IT awareness workshop. The game can also be used as an energizer during various IT workshops. While playing the game, attendants in the workshop find out to what extent Green-IT is already a part of their company's IT structure and in what areas improvements can be made. Of course this should always go hand in hand with an organisation's business strategy. According to Atos Consulting, this game (and workshop) is especially interesting for CIO's (Chief Information Officer), IT managers (and unit), data center manager and MVO (Motor Vehicle Operator) managers. However, during this research work it was percieved that this game (workshop) should be interesting to all members of an organisation at thier different levels.

The Greenology board game is based on the popular game Monopoly where, instead of streets, Green-IT solutions can be traded. (See figue 5.) The game consists, (except for some obvious Green-IT solutions) of a number of surprising solutions of which the IT manager might not be aware of.

❖ **Green-IT awareness workshop** The Green-IT solutions on the board game are divided into three dominant motivators for IT managers to engage in Green-IT (Atos Consulting, 2009) (see figure 5):

1. The **idealist** uses his IT organization as a way to positively influence the environmental issues in the world.
2. The **opportunist** uses Green-IT mostly as a marketing tool. With Green-IT he can position his (end) product/service as more Green.
3. The **controller** uses Green-IT solutions to realize cost savings within his company.

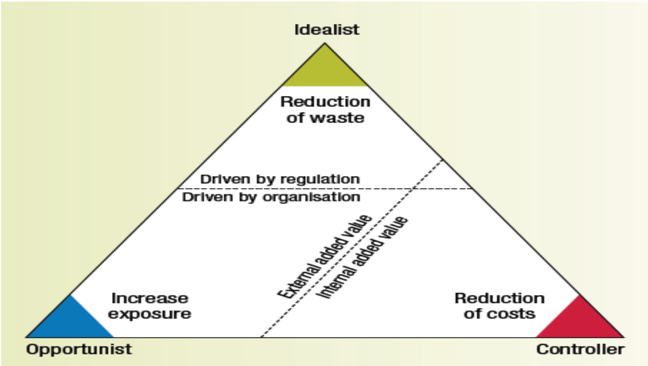

Figure 5A view of the monopoly board

CONCLUSION, FURTHER WORK AND RECOMMENDATIONS

The purpose of this research work was to determine the carbon footprint of an educational institution in Nigeria and to design a Generic Green IT Model for possible adoption. However, Green IT is not just about running efficient data centres. It encompasses IT's role in causing and tackling emissions. According to GITAM (2008) while IT can be held accountable for reducing its 2% of global CO_2 emissions, it has a role to play in tackling the remaining 98%.

Hence, this research work found out that the institution emits **970,653.5761kg of** CO_2**e (see table 1).** It is then proposed that the institution should adopt the **Generic Green IT Model** designed in figure 4 and also adopt the approaches to Green Computing on Campus as discussed in this research work (see section 2.4).

This research work may be extended by a number of future research projects in the following ways:

- The reliability of this study could be verified by having an independent researcher calculate the CO_2 emissions using the same sample data to ascertain whether there is any agreement between the two sets of calculations.
- Full Greenhouse accounting should be conducted to cover scope 1, scope 2 and scope 3 repectively.
- The validity and reliability of the model should be empirically verified.

According to Energy Policies for CO_2 emission reduction, combustion of fossil fuels accounted for an estimated 80% of the CO_2 emission originating from human activities in industrialised countries.

Hence, the most important recommendation for the institution is that it should reduce its CO_2 emission. This is because the CO_2 emission calculated, is high despite the fact that all scopes were not calculated. This can be achieved by adopting the designed Generic Green IT Model. Also, calculate and monitor its CO_2 emissions every year. This is necessary in order to provide evidence of CO_2 emissions reduction. Also, the school should give incentives to staffs to purchase modern cars, as new cars consume less fuel/diesel.

Furthermore, documentation need to be improved as regards the number of time the institution's vehicles were used in a week or month; kilometer covered or places visited with the institutions' vehicles as well as visitors coming into the campus.

As concern for environmental sustainability grows, it is recommended that the National Education Commission should attach certain benefits to defined level of emissions reduction per period. These could range from increase in admission quota to increased fund allocation, more project approvals or sponsorship among other various options to stimulate institutions to imbibe responsible evironmental preservation behaviour.

REFERENCES

1. Atos Origin SA. April 2009.
2. Bartkovich J. (2008): The Greening of IT. Leaflets. http://www.league.org/league/projects/sustainability/files/leaflets%20number%201.pdf. Retreaved: March 1, 2012
3. Brander M., Sood A., Wylie C., Haughton A. and Lovell J. (2011): Technical Paper on Electricity-specific
4. emission factors for grid electricity. ecometrica.
5. DEFRA (2010): 2010 Guidelines to Defra / DECC's GHG Conversion Factors for Company ` Reporting: Methodology Paper for Emission Factors
6. DiMaggio, P. J. and Powell, W. (1983) The iron cage revisited: Institutional isomorphism and collective rationality in organizational behaviour, American Sociological Review, 48 (April), 147-160.
7. Habil. K. P. (2007). Nigeria in the dilemma of climate change. www.resourceconservation.mb.ca Retrieved February 23, 2012
8. Ecometrica (2011) - emissionfactors.com
9. EPA (2011), Waste Reduction Model (WARM), http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html. Retrived 33 May 2011.
10. Esty, D. C. and Winston, A. S. (2006) Green to Gold: How Smart Companies Use Environment Strategy to Innovate, Create, Value, and Build Competitive Advantage, Yale University Press.
11. González, P.D.R. (2005). Analyzing the factors influencing clean technology adoption: A Study of the Spanish pulp and paper industry, Business Strategy and the Environment 14(1), 20-37.
12. Gartner. (2007). Gartner Estimates ICT Industry Accounts for 2 Percent of Global CO2 Emissions. Retrieved August 12, 2011, from Gartner Newsroom: http://www.gartner.com
13. Gartner. (2008). Gartner Says Changing the Cost Structure of IT Will Become a Business Imperative for Most CIOs. Retrieved December 18, 2011, from Gartner Newsroom: http://www.gartner.com
14. Gartner. (2008). Green IT Services as a Catalyst for Cost Optimization. Retrieved December 18, 2011 from Symantec: http://www.symantec.com
15. Graeme P.(2010). The Green IT FrameworkStructure and Metrics. For International Green IT Awareness Week, http://www.greenitweek.org/downloads/GreenITFrameworkOverview.pdf. Retrieved:February 17, 2012.
16. Green Marketing TV (2011). www.greenmarketing.tv/2010/07/15/what-is-green-it/ Retrieved date: March 23, 2012.
17. IPCC 2006 Guidelines, Volume 1, Chapter 2.

18.McWilliams, A. and Siegel, D. (2001) 'Corporate social responsibility: a theory of the firm perspective', Academy of Management Review 26(1): 11 7-127.
19.Minita Sinha (2011); Green Information Technology: A Strategy To Become Socially Responsible Software Organization. Vol. 1 Issue 2 July. International Journal Of Enterprise Computing And Business Systems
20.Retrived 12th feb., 2012. http://www.ijecbs.com
21.Molla, A. (2008). GITAM: A Model for the Adoption of Green IT. 19th Australasian Conference on Information Systems, (pp. 658–668). Christchurch. http://www.bsec.canterbury.ac.nz/acis2008/Papers/acis-0152-2008.pdf. Retrieved: February 11, 2012.
22.N. Nayab (2011) • Related Guides: Green Technology, Kyoto Protocol.
23.Olson, E.G (2008) Creating an enterprise-level "green" strategy", The Journal of Business Strategy, 29(2), 22-30.
24.Porter, M.E. and Kramer, M.R. (2002) 'The competitive advantage of corporate philanthropy', Harvard Business Review 80(12): 56-68.
25.John T. Thompson (1999-2012). Three Approaches to Green Computing on Campus
26.Copyright EDUCAUSE
27.Walser, Maggie L. (2010); Reducing carbon footprints.
28.World Resources Institute (WRI). The Greenhouse Gas Protocol- A Corporate Accounting and Reporting Standard. Revised Edition. March 2004 , Printed in USA. Retrieved feb. 23, 2012 http://www.wristore.com
29.http://www.eolss.org.
30.http://timeforchange.org/copyright.
31.www.climatechangeconnection.org. Retrieved feb. 23, 2012.
32.http://www.kas.de/nigeria/en/publications/ Retrieved march. 23, 2012.
33.http://www.wri.org/project/wri-co2-commitment.
34.http://mccgreenitcampusmodel.pbworks.com/w/page/20625600/MCCs%20Green%20IT%20Campus%20

Authors Profile:

Awodele, Oludele holds a Ph.D. in Computer Science from the University of Agriculture, Abeokuta, Nigeria. He has several years experience of teaching computer science courses at the university level. He is currently a lecturer in the department of Computer Science, Babcock University, Nigeria. He is a full member of the Nigeria Computer Society (NCS) and the Computer Professional Registration Council of Nigeria. His areas of interest are Artificial Intelligence, Cloud Computing and Computer Architecture. He has published works in several journals of international repute.

Malasowe Bridget O. is currently a lecturer in the Department of Computer Science, College of Education, Agbor, Delta State. She has a B.Sc. Degree in Computer Science, from the University of Benin, Benin – City. Edo State and a Postgraduate Diploma in Education from Delta State University, Abraka, Nigeria. She is currenly running her M.Sc. program in Computer Science with Babcock University, Illisan, Ogun State, Nigeria. She has several years of experience in teaching computer science courses at the college of education. Her current M.Sc. research work is on Green Information Technology.

Onuiri, Ernest Enyinnaya is a Graduate Assistant in the Computer Science Department of Babcock University. He is a graduate of Computer Science (Technology) from Babcock University. He is a Cisco Certified Network Professional [CCNP] and a Certified Security+ Professional. He is currently doing his M.Sc. in Computer Information Systems at Babcock University. His areas of interest include networking and security, cloud computing, intelligent computing and bioinformatics.